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THE JOURNAL OF
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AN EXPERIMENTAL INVESTIGATION OF ASSOCIATION AND DISSOCIATION IN LEARNING

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Chicago, Illinois

STATEMENT OF PROBLEM

One of the most important, and yet one of the most enigmatic problems in education and learning is the problem of sameness and separateness. Knowing, thinking, adjusting to, and the adapting of the human environment, all involve a process of establishing generalizations and particularizations. In fact, man's very existence is dependent upon his ability to carry-over 'retentions' from event to event and at the same time remain sensitive to the 'meanings' and uniqueness in events. And it is part of the teacher's job to aid and encourage each pupil in developing this dual ability.

HISTORICAL BACKGROUND

Many theoretical and experimental studies have been made which compare these association* and dissociation† aspects of

[1] The author is at present a graduate student in the Department of Education of the University of Chicago. This article is an abridgement of a Master's thesis with certain added material. A more detailed description of the experimental apparatus may be found in Dutton, E. *Association and Dissociation in Learning.* Unpublished Master's thesis, Department of Education, University of Chicago, 1940.

* Association will be used throughout this paper as the generic term to denote the process of gathering together the meanings or relationships between elements in a neutral field, including the connotations of the terms: conditioning, connection, integration, generalization, and conception.

† Dissociation will be used throughout this paper as the generic term to denote the process of separating meanings or relationships from the other surrounding elements in a neutral field, including the connotations of the terms: individuation, discrimination, differentiation, particularization, and perception.

learning. A few of the studies are reviewed briefly in the following paragraphs.

Lashley[7] (pp. 468–69) has pointed out that the difficulty of learning may be due either to the quantity of associations required or to difficulties in recognizing the uniqueness in the material to be learned. Allport[1] (pp. 132–47) has emphasized the importance of both differentiation (dissociation) and integration (association). Brown[3] has declared unequivocally that development proceeds both by unification and organization, and at the same time by discrimination and differentiation. He states that dissociation is just as normal and necessary as mental unity. Although Lashley, Allport, and Brown have presented the importance of both association and dissociation, they have failed to point out any interaction or mutual dependence of the two processes.

One of the earliest attempts to compare experimentally the process of association with the process of dissociation was made by Winch.[8] He found that the 'deductive' method (which maximizes ease of association) was more effective when the children were tested precisely on what they had learned, but that the 'inductive' method (which maximizes ease of dissociation) was more effective when the children were tested on new material.

Fowler[4] in an experiment with school children, using relations between geometrical figures that would be analogous to grammatical relations of adjectives and nouns and of adverbs and verbs, found that the 'deductive' method of presentation (which maximizes ease of association) was superior to the 'inductive' method of presentation (which maximizes ease of dissociation) for definitional reproduction of the learned unit. However, he also found that a combination method of presentation was much superior in functional efficiency to either of the two methods alone.

Hull[6] found, among other conclusions, that in the evolution of concepts an abstract presentation (which maximizes ease of association) and a concrete presentation (which maximizes ease of dissociation) were about the same in functional efficiency; an alternating combination of abstract and concrete presentations was distinctly more efficient than either alone; and a 'pointing-out' of the abstraction within a situation of concrete examples was the most efficient of all.

One explanation of these findings might be that a concept externally associated (the abstract presentation) is more easily learned as a unit, but more difficult to dissociate from surrounding similarities when applied to concrete situations. A concept learned from concrete examples is more clearly dissociated from surrounding similarities, but more difficult to gather into a unified whole. Adding the effect of two presentations which are unequal in efficiency for the two factors of association and dissociation would be more efficient than either presentation alone. And a temporal combination of the two presentations will necessarily be more efficient still. However, a better explanation of Hull's findings, as well as those of Winch and Fowler, might be that a condition of mutual dependence exists between associative and dissociative processes.

Gibson's study[5] presents an hypothesis which superficially seems to be identical with that investigated in the present study. She points out that there is a tendency for a response which is being learned in respect to a particular stimulus to also occur, or to 'generalize,' in respect to other similar stimuli with which it has not been previously associated, and that discrimination among the items to be learned is fundamental to the learning process. There is a clear recognition of the interaction of association and dissociation in her paper, but she admittedly deals only with verbal learning, and only with certain experimental facts such as transfer, interference, and retroactive inhibition. Also, her hypothesis seems somewhat obtuse because of her lack of clearness in first dividing the conditioned response (association) into association and discrimination (dissociation), and then in turn dividing discrimination into the subconcepts of generalization (association) and differentiation (dissociation). She also leaves out of her argument the possibility that an increase in specificity of learning might be obtained by pure practice. This possibility has been considered in the present experiment.

THE PRESENT STUDY

The present study was undertaken to test the hypothesis that *the process of association and the process of dissociation are bi-polar, covariant functions or mutually dependent aspects in learning.* In other words, the study was designed to compare the improve-

ment in learning gained: (1) by emphasis upon the related or connected elements in a learning situation; (2) by emphasis upon the separation or differentiation of a particular configuration from the total field; (3) by a concomitant emphasis upon both aspects. Can dissociation be tenably held as a subordinate law or effect of the general process of association? Can association be tenably held as a subordinate law or effect of the differentiation process? Or might not each aspect be mutually dependent upon the other for its effectiveness in learning?

Every experimental investigation is set up on the basis of a number of assumptions. In the present study it was assumed:

1) That learning is equal to its overt manifestations indicated by memory, recognition, and recall.

2) That the amount of memory, recognition, and recall is proportional to the degree of sharpness with which the specified particular is overtly recalled.

3) That the degree of sharpness of recall in dealing with a locus on a two-dimensional field is inversely proportional to the square of the distance between the locus and the recall.

4) That an obvious association or connection is best induced by repetition, and, conversely, that an obvious association is minimized by no repetition.

5) That within a specified area dissociation is best induced by a division of the area into unique elements, and, conversely, that dissociation within a specified area is minimized by a lack of any divisions.

EXPERIMENTAL MATERIALS

Laboratory apparatus was used in order to control as much as possible such factors as, differences in objectives, differences in material, differences in motivation, partiality in testing procedure, partiality in teaching effort and ability, temporal differences in appearance of effects, and similar factors which more or less influence any classroom comparison of association and dissociation.

The apparatus used for this investigation was designed so that the influence of association and dissociation could be alternately reduced to a minimum. It was assumed that the most practical

way of minimizing the associative learning of an obvious connection was to allow no repetitions. It was also assumed that the most practical way of minimizing the dissociation of a particular learning configuration was to present a uniform stimulus area with no divisions which would inherently identify particular loci within that area. Therefore, a box was built to present two rubber screens or 'fields', one divided into unique loci, and one having no marks or identifiable loci. A moveable (from the subject's viewpoint) bull's-eye or sensitive spot was hidden behind the two interchangeable screens. Actually, eight such bull's-eyes, which could be thrown in or out of an electric circuit by means of switches, were built into the back of the box. Each bull's-eye was made exactly three-fourths of an inch in diameter, and was built in the backboard of the box in such a manner as to avoid any obvious position relationships between it and the frame of the rubber screens, and between it and the other bull's-eyes.

The rubber screens were built to leave an effective field of eight and one-half inches by eleven and one-half inches inside their wooden frames. The non-differentiated screen was a solid black throughout its entire area. The differentiated screen was made by covering one of the rubber screens with one hundred fifteen different nonsense designs drawn with printer's ink on white rubber patches cut to correspond to the size of the bull's-eyes. Eight of these designs were cemented on the rubber screen directly over the positions of the eight bull's-eyes. The rest of the designs were randomly cemented on the remaining area as close together as possible while preventing all countable alignments in rows.

Eight cardboard sheets to go between the rubber screens and the backboard containing the bull's-eyes were made in order to hold a recording sheet during the tests of memory and to block out all indication of the seven other bull's-eyes throughout any one presentation. A single hole was cut in each cardboard sheet to correspond in each case with a different one of the eight bull's-eyes.

The box was approximately six inches deep with an open face toward the subject. A one-inch slit was cut in the top of the box directly in front of the backboard to permit the exchange of rubber screens. A small light was placed in the middle of the

bottom of the box. It was equipped with a reflector to prevent the light from shining in the subject's eyes. A symbolic target-type bull's-eye was placed above the top of the box. Its center was a small light which was sufficiently covered with black adhesive tape so as to permit no light to reflect from the subject's clothing or face back into the box when the light inside the box was out. An electric circuit was established from a transformer through the open points of a relay which would light the bulb inside the box, and which would supply the current to close the relay when contact was made in a spring-switch attached to each of the bull's-eyes. Another circuit from the transformer was sent through the closed points of the relay which would light the bulb in the symbolic target, ring a loud bell, and keep the relay closed. Thus when contact was made in a spring-switch by hitting a bull's-eye (which had previously been thrown into the circuit), the relay was closed and the light within the box was turned off. Immediately, the making of the circuit through the closed points of the relay turned on the light in the symbolic target, rang a loud bell, and kept the relay closed, all until the entire current was shut off at the transformer.

The entire box inside and outside, including the wooden frames of the rubber screens, was painted a uniform flat-black. A black cloth curtain, which could be rolled up and down on a long dowel-rod tacked in its bottom hem, was hung over the open side of the box. The curtain was used to prevent the subject from seeing the rubber screens before he began his trials, and to prevent him from getting a second look even at the general position of his hand after the unrepeated presentations.

A five-eighths-inch dowel-rod, approximately twelve inches long and rounded at the end, was used in searching for and hitting the bull's-eyes. This kept the size of the searching medium constant from subject to subject, and also made the experiment more interesting to the subjects. The apparatus was used in a semi-dark room. The box was placed on a table facing the subject who was seated on a stool. A small table lamp was turned on during the intervals between presentations of the fields and the tests of recall.

An attempt was made to get as wide a range of subjects as possible, but controls in choosing the subjects could not be very

exacting because all of the subjects were volunteers. The largest disparity was in sex. Twenty-six males and four females were used. The group contained seven graduate students, four college students, ten high-school students, three janitors, three stenographers, two musicians, and one mechanic. The age range was from fourteen years to sixty years of age. No attempt was made to classify the subjects by intelligence scores, but it was felt that the range in occupational status was sufficient to exclude any drastic selection in mental ability.

PROCEDURE AND CONTROLS

Four types of presentation were used in this investigation: one with association reduced to a minimum, one with dissociation reduced to a minimum, one with both aspects reduced to a minimum, and one with both aspects at a maximum. It was recognized that it was impossible to eliminate the influence of either association or dissociation in any learning situation. But by comparing the influence in improvement gained by the presentation of each factor when the other was minimized, with the presentation when both were at a minimum, and with the presentation when both were at a maximum, their effectiveness maximized singly and in combination can be measured.

From the subject's point of view there could be no doubt about the connection between hitting a particular locus in a field and the ringing of a loud bell which indicated he had 'hit the mark.' The subject's problem was simply to fit a particular locus into the associational pattern. It seems reasonable to assume that the obvious connection of a particular locus with the hidden bull's-eye would be associated best through repetition. Association induced by repetition, however, by no means implies that the amount of association is 'proportional' to the number of repetitions. Exploratory experiments seemed to indicate that association was more a function of the very small time interval between the finding of bull's-eye and the first repeated hit on it, rather than of the mere act of repeated hitting. Sixty-five per cent of the subjects were allowed just two successive hits on the bull's-eye for the repeated type presentations. It had been contemplated to compare the scores of these subjects allowed a

single repetition with the scores of twenty-five per cent of the subjects who were allowed five successive hits and with the scores of ten per cent of the subjects who were allowed sixteen successive hits on the repeated type presentations. However, such a comparison became meaningless when all of the subjects scored a perfect score on the repeated differentiated presentation except one subject who was allowed five repetitions on the repeated presentations and one subject who was allowed sixteen repetitions.

Dissociation for this particular experimental situation is the process of establishing a negative valence for all of the loci in the field except the one locus which is connected with ringing the bell. It may be argued that division of a field simply multiplies possible associations, that discrimination simply is an association with each of the elements. The author believes there is no semantical argument against calling dissociation 'negative association,' but that there are obvious syntactical reasons for not doing so. The naming is not, however, particularly relevant to this investigation. That a process of separation exists in learning can hardly be denied. An objective or 'given' dissociation is only accomplished by a division of the experienced field before the subject encounters it. As previously mentioned, the division of the field used in the experimental apparatus was accomplished by the use of one hundred fifteen different nonsense designs. An unrepeated differentiated presentation was given the subjects to determine the effectiveness of dissociation alone in producing recall of the learned response.

To keep the presentation instructions as nearly alike as possible, they were typewritten and read to each subject by the experimenter. There were, of course, minor changes in the instructions from subject to subject due to changes in the order of presenting the different rubber fields. The order in which the presentations were given was systematically varied. Since proportionately low scores on the repeated non-differentiated and the unrepeated differentiated presentations were crucial for the affirmation of the hypothesis, they were presented in an order which would be most partial towards a negation of the hypothesis. This meant the two crucial presentations were chiefly confined to central positions. Approximately seventy-five per cent of the subjects were given one of the other types of presenta-

tion first, and approximately eighty-five per cent of the subjects were given both of the crucial presentations before they were given their last presentation. Within the central positions in the order of presentation, the two crucial types of presentation were proportionately interchanged to avoid preferentiality for either of them.

The preliminary searches for the hidden bull's-eyes were carried out by each subject without any suggestions or hints from the experimenter. Many different methods of attack were exhibited by the subjects, but on the whole they resembled a planned procedure by horizontal or vertical rows. The time needed to find the bull's-eye varied a great deal, depending upon chance, the type of field presented, and upon each subject's acuity in keeping his hits close together. The ringing of the loud bell produced the desired effect of startling and breaking the subject's attention even after it had been experienced five or six times. The lowering of the curtain in front of the box was effective in keeping the subject from indirectly repeating his perception of the location of the bull's-eye from the position of his hand.

In order to provide a constant and distracting activity during the time intervals between presentation and testing of recall, a list was constructed of words paired with close synonyms and another list of the same words paired with antonyms. The subjects were requested to write similarities and differences for each pair of words during the time intervals. This task proved to be very effective in distracting the subject's attention during the intervals between the presentations and the subsequent tests of recall.

In spite of indications from an exploratory use of the apparatus that variations between two minutes and twenty-four hours in the length of time interval between finding the bull's-eye in any of the presentations and the tests of recall did not affect the sharpness of recall, it seemed advisable to use varying lengths of time intervals to prevent possible favoring of one type of presentation by the use of a single time interval. Practical administrative considerations, such as keeping the activity during the interval constant for all of the individual's presentations, made it necessary to limit the length of time interval to not more than

ten minutes. Consequently, the length of time allowed different subjects was varied from two to ten minutes. Of course, the length of time interval for any one individual subject was kept the same for all four presentations by means of a stop-watch.

Each bull's-eye was built in a position calculated to avoid all obvious position relationships between it and the framework of the rubber fields, and between it and the other bull's-eyes, but it was possible that sharpness of recall might be influenced by the particular position of the bull's-eye. To control the possibility of such an influence, three or more different bull's-eye positions were used in giving each type of presentation, but no one bull's-eye position was used more than once for any one subject.

For the purpose of recording the subject's precision of recall, the backs of the rubber screens were painted with a special glycerin base ink. A record sheet for each test of recall was held firmly in place by corner patches on the cardboard sheets described above. The correct position of the particular bull's-eye used was recorded by drawing a circle through the hole in the cardboard sheet.

It was assumed that the sharpness of recall was most clearly indicated by the area of the circle subtended when the distance between the center of the recall and the center of the correct locus was used as the radius. In the comparison of two recalls the π cancels out. This leaves the sharpness of recall inversely proportional to the square of the distance between the recall and the center of the correct position. This distance was measured in units equal to the radius of the bull's-eye. When scores obtained in this manner are multiplied by one hundred, the product is a score of one hundred for a perfect recall and scores proportionately lower for less precise recalls. The accuracy of the apparatus was not great enough to warrant any measurement in fractions of less than one-half unit, and the difference in the numerical score obtained was not sufficient to warrant the use of the one-half fraction except in recalls of less than one unit from the correct location of the bull's-eye.

The method of scoring the tests of memory on the differentiated presentations had to be somewhat altered because the designs forced a response into distances of zero, two, four, six, eight, or ten radius-units. It was decided to score the sharpness of the

recalls on the differentiated presentations as inversely proportional to the number of designs within the areas subtended by the odd numbered radii. This made the scores on the differentiated presentations more comparable to the scores on the undifferentiated presentations, but, of course, the two sets of possible scores were still not exactly comparable. However, the purpose of the experiment was not to compare quantitatively the effectiveness of association versus dissociation, but rather to compare the effectiveness of association and dissociation singly with their respective effectiveness in combination. For this purpose the two methods of scoring are sufficiently comparable.

It can readily be seen that this method of scoring excludes the possibility of obtaining a normal distribution of numerical scores. The unsquared linear distance between the center of the recorded recall and the center of the correct locus gives a somewhat more normal distribution, but scores based on this measure completely distort the relative precision of recall. It is obvious that the difference between a score of five linear units and a score of six linear units does not represent a difference in sharpness of recall at all comparable with a difference between a score of one linear unit and a score of two linear units.

ANALYSIS OF DATA

The frequency distributions of the scores obtained by thirty subjects for the four types of presentation are shown in Table 1. The mean scores with the standard deviations and the standard errors of the means are shown in Table 2.

Repetition and differentiation give considerably higher mean scores when presented in combination than they do when presented separately. This mutual interaction of association and dissociation implies that all arguments and experiments based on an assumed independence of the two factors and making a versus type of comparison are irrelevant. This implication agrees with the previously cited findings of both Hull and Fowler, who found that a combination of associational and dissociational presentations overshadowed the efficiency of either type of separate presentation, and it also helps to explain the controversial results of whole versus part experiments in learning.

TABLE 1.—FREQUENCY DISTRIBUTION OF SCORES FOR COMPARED PRESENTATIONS

Score	Unrepeated Non-differentiated Presentation	Repeated Non-differentiated Presentation	Unrepeated Differentiated Presentation	Repeated Differentiated Presentation
1	3	...	2	...
2	1	...	2	...
3	4	1	1	...
4	1	2	...	...
5	...	...	8	1
6	8	3	...	...
11	4	10	...	...
15	...	...	9	1
25	6	8	...	...
45	3	5	...	...
100	...	1	8	28
Total	30	30	30	30

TABLE 2.—MEAN SCORES OF 30 SUBJECTS FOR DIFFERENT TYPES OF PRESENTATION

Type of Presentation	Mean Score of Thirty Subjects	Sigma	Sigma of the Mean
Unrepeated Non-differentiated	13.3	±13.4	±2.48
Repeated Non-differentiated	22.1	±19.8	±3.67
Unrepeated Differentiated	32.8	±40.7	±7.56
Repeated Differentiated	94.0	±22.5	±4.18

From another point of view, the effect of repetition alone may be compared to its effect when combined with differentiation. The effectiveness of repetition alone is obtained by subtracting the mean score on the unrepeated non-differentiated presentation (where both association and dissociation were minimized).

from the mean score on the repeated non-differentiated presentation (where only dissociation was minimized). The effectiveness of repetition when combined with differentiation is obtained by subtracting the mean score on the unrepeated differentiated presentation (where dissociation alone was present) from the mean score on the repeated differentiated presentation (where both factors were present). The effect of differentiation alone may be compared to its effect when combined with repetition in a similar manner by subtracting the mean scores of the unrepeated and repeated non-differentiated types of presentation from the corresponding differentiated types. Table 3 shows the mean improvement gained by the addition of repetition to non-differentiated and differentiated presentations, and the mean improvement gained by the addition of differentiation to unrepeated and repeated presentations.

TABLE 3.—MEAN IMPROVEMENT GAINED BY ADDITION OF REPETITION AND DIFFERENTIATION

	Mean Improvement Gained	Sigma of the Difference	C.R. Showing Significance of the Difference
Repetition added to non-differentiated presentation.....	8.8	±4.43	1.98
Repetition added to differentiated presentation.....	61.2	±8.64	7.06
Differentiation added to unrepeated presentation...	19.5	±7.96	2.45
Differentiation added to repeated presentation.....	71.9	±5.57	12.90

Subtracting the mean scores on unrepeated presentations from the mean scores of similar repeated presentations, and subtracting the mean scores on non-differentiated presentations from similar differentiated presentations, points out the striking mutual dependence of association and dissociation. Also, it is

logical to expect that the difference between two presentations which differ only in the presence of one factor, is due to the influence of that factor. When mutually interacting factors are involved, however, this logic is not found to be accurate. In fact, it is a proof of interaction when such an inaccuracy is found. It is apparent from Table 3 that the repeated differentiated presentation cannot gain sixty-one points when repetition is added to differentiation and seventy-two points when differentiation is added to repetition, when the improved score itself is less than one hundred points.

TABLE 4.—FREQUENCY DISTRIBUTION OF LINEAR SCORES FOR COMPARED PRESENTATIONS

Linear Score in Radius Units from Correct Locus	Unrepeated Non-differentiated Presentation	Repeated Non-differentiated Presentation	Unrepeated Differentiated Presentation	Repeated Differentiated Presentation
10	...	...	2	...
9	...	...	...	...
8	3	...	2	...
7	1	...	...	...
6	4	1	1	...
5	1	2	...	...
4	8	3	8	1
3	4	10	...	...
2	6	8	9	1
1	3	5	...	...
0	...	1	8	28
Total	30	30	30	30

To bring out the covariant dependence between association and dissociation without such inaccuracies, probably the best method is to compare the difference between the 'sum' of the influence of the two factors alone with the influence of the two factors in combination. The amount of mean improvement gained by repetition alone added to the amount of mean improvement gained by differentiation alone is 28.3 score points. The

amount of mean improvement gained by repetition and differentiation in combination is 80.7 score points. This comparison indicates that association and dissociation when presented in combination improved the specificity of learning nearly three times more than the sum of their separate influences on learning.

As previously mentioned, a scoring of the recall tests on the basis of linear units distorts the relative specificity of learning examined in this experiment. Nevertheless, even when the data are presented in terms of linear scores, the same conclusions are warranted. Table 4 shows the frequency distributions for linear scores, Table 5 shows the mean linear scores with their standard deviations and the standard errors of the means, and Table 6 shows the mean improvement gained in linear scores by the addition of repetition and differentiation. The comparison between improvement gained by association alone and dissociation alone with improvement gained by association and dissociation in combination is not as striking when the data are presented in this manner. But even in linear units the improvement gained by the combination presentation is nearly twice the 'sum' of that gained by association alone added to that gained by dissociation alone.

TABLE 5.—MEAN LINEAR SCORES FOR DIFFERENT TYPES OF PRESENTATION

Type of Presentation	Mean Scores of Thirty Subjects	Sigma	Sigma of the Mean
Unrepeated			
Non-differentiated....	3.97	±2.074	±.379
Repeated			
Non-differentiated....	2.63	±1.329	±.243
Unrepeated.....			
Differentiated.....	3.07	±2.863	±.526
Repeated			
Differentiated.....	.20	±.792	±.145

The covariant dependence of association and dissociation implies that for maximum effectiveness education must include both general and specialized courses. Students should be given learning experiences which allow them to build generalizations,

skills, and attitudes from empirical facts, and at the same time should be given experiences which emphasize that no two situations—perceptual, verbal, or emotional—are ever exactly alike. Furthermore, educational objectives will be reached most effectively if both pupil-centered activities, which dissociate general

TABLE 6.—MEAN LINEAR IMPROVEMENT GAINED BY ADDITION OF REPETITION AND DIFFERENTIATION

	Mean Improvement Gained	Sigma of the Difference	C.R. Showing Significance of the Difference
Repetition added to non-differentiated presentation.....	1.34	±.451	2.97
Repetition added to differentiated presentation.....	2.87	±.546	5.27
Differentiation added to unrepeated presentation.....	.90	±.649	1.39
Differentiation added to repeated presentation.....	2.43	±.283	8.59

interest-gestalts into more discriminating values, and teacher-organized content, which presents those ideas that are the generalizations built from the historical experience of society, are utilized as learning situations. And if the teacher can present 'temporal' combinations of all these associative and dissociative aspects, he will allow his students to reach their highest level of efficiency in learning.

SUMMARY AND CONCLUSIONS

To test the hypothesis that association and dissociation are mutually dependent functions in learning, apparatus was designed which reduced association and dissociation to a mini-

mum. The separate influences of association and dissociation in improving precision of recall were compared with the influence of the two factors in combination.

It was found for the number of subjects used:

1) That association when present with a minimum of dissociation improved the precision of recall beyond that obtained when both were at a minimum.

2) That dissociation when present with a minimum of association improved the precision of recall beyond that obtained when both were at a minimum.

3) That association and dissociation when present together improved the precision of recall approximately three times as much as the 'sum' of the improvement added by their separate influences.

The evidence definitely indicates the validity of the hypothesis. Within the scope of this investigation it must be concluded that association and dissociation mutually interact, that the two processes are mutually dependent and covariant, that they are not causally related, and that neither association nor dissociation has priority over the other in learning.

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THE RATE OF FORGETTING

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Sixty-two years ago Ebbinghaus[1] published his study on memory. This study was not only the first in the general field of learning but was the first experimental study of the higher mental processes. Ebbinghaus constructed and used for the first time nonsense syllables. Although there were several variations in his experiment, in his principal study he committed lists of eight series of thirteen nonsense syllables each. He repeated these at the rate of two-fifth seconds between syllables with fifteen seconds between series. In his earlier studies he learned the syllables to two correct reproductions. In his later studies he learned them to one correct reproduction. Retention was measured by the relearning or saving method. Ebbinghaus' results showed that after one hour it required forty-five per cent as much time to relearn to one correct reproduction as in the original learning. After twenty-four hours sixty-seven per cent as much time was required as in the original learning. Forgetting became progressively slower thereafter.

Despite the numerous references to these results probably their full depressing import is not generally appreciated. Are these results typical of forgetting of most if not all kinds of material; do we forget nearly one-half of what we have learned within one hour and two-thirds within one day? This is the problem of this paper.

Forgetting is a function of several factors, the chief of which will be enumerated.

1) Time.—Ebbinghaus realized the fact that forgetting is a function of time and discovered that the relation was logarithmic. The slope of the forgetting curve he expressed as $R = A - B \log t$ in which R was retention; t, time and A and B constants. Almost all the results of studies of forgetting have been represented by a negatively accelerated curve, but few have found as rapid a loss as Ebbinghause.

2) Materials (Kind and Amount).—Ebbinghaus used lists containing one hundred four nonsense syllables. Rodossaljewitsch[2] also used nonsense syllables but he found only thirty-

three and one-third per cent deterioration in twenty-four hours. Boreas[3] used fifteen nonsense syllables with twenty subjects. He found forty per cent deterioration in twenty-four hours. When sense material, words or poetry was used, Strong[4] found almost as rapid forgetting as Ebbinghaus but Boreas, Bean[5], Rodossaljewitsch, Magneff[6] and others found considerably less rapid forgetting. Although the experimental evidence is meager, it is generally believed that logical or rational material is retained longer than words or nonsense syllables[7]. Despite popular opinion that motor skills are retained better than other kinds of material, the experimental results do not support this position. If motor skills are retained better this seems to be true only because they are generally overlearned[8]. The memory for geometrical figures indicates that when the forms are complex the learning is slower than with nonsense syllables, but the rate of forgetting is very similar[9]. It no doubt deserves at least passing mention that Gestalt psychologists[10] believe there is a tendency for certain changes to occur in the recall of such material. This change they believe illustrates the law of pregnance. But Woodworth[11] considers this evidence inconclusive.

There is an extensive list of studies of the influence of the length of the material on the rate of learning. Thurstone[12], for example, found the time increases per unit approximately as the square root of the number of items. But there are few studies of the effect of the length of material on recall. Woodworth[13] using the paired associates method found that with equal learning there is better retention with longer lists of words; five words four per cent, ten words sixteen per cent, twenty words thirty-six per cent, thirty words thirty-four per cent.

3) Method of Learning.—Most studies of methods of learning have been concerned with their effects upon rate of learning. But Cain and Willey[14] studied the effects of massed and distributed practice upon the retention of twelve nonsense syllables. They found two times as rapid deterioration with massed as with distributed learning.

4) Motivation and Interest.—No very systematic study seems to have been made on this subject. One closely related study was that of Jenkins[15] in which one group of subjects read a list of syllables to another who were to learn them. Twenty-four hours after the learning, unexpectedly for the instructional group,

both were required to recall all that they could remember. The learner group averaged 15.9 ± 2.4 and the instructional group 10.8 ± 3.6 units. Alper[16] in contrast found that explicit instructions to learn did not facilitate either immediate learning or delayed recall when compared with incidental learning.

5) Age.—Thorndike[17] has conducted one of the most extensive studies of the effect of age on learning, using various kinds of materials. He found a gain in learning rate up to twenty-five years. After that there was a gradual decline with an average loss of thirteen per cent in sheer ability to learn by age forty-five.

Gilbert[18] matched two groups on a vocabulary test, one aged twenty to twenty-nine years and the other, sixty to sixty-nine. The two groups were tested on six different types of material for immediate memory and on three types of material for delayed recall. On every test the younger group did significantly better (c.r's. 5.0 to 17.6) on immediate memory. The loss was less in the brighter group of older persons than with the duller group. In delayed recall—the amount of delay was not indicated—there was in general greater loss for the older group than on immediate recall. The greatest loss was for delayed recall of a Turkish-English vocabulary test (c.r. 19.15).

6) Overlearning and underlearning.—Ebbinghaus found forgetting less rapid the better the original learning. Other studies such as those by Krueger[19] and Jost [20] have supported these findings. In fact it was upon the basis of his studies that Jost formulated his well-known laws of forgetting.

7) Method of reproduction.—Luh[21] used five different methods of measuring recall. Recognition showed the least rapid rate of forgetting. Relearning was next to worst within the first few hours, but took second place after twenty-four hours. Reconstruction, reproduction and anticipation came in the order named.

8) Retroactive inhibition.—Studies by McGeoch[22] and others have shown that recall is influenced by what intervenes between the learning and the recall. Jenkins and Dallenbach[23] and Van Ormer[24] have shown that sleep produces the least loss in recall. Learning material in the interim similar to the original material causes most loss. Ebbinghaus is not clear in reporting this aspect of his study, but it seems probable that he committed other series of syllables between learning and recall. This may have been one other cause for the rapid forgetting reported by him.

9) Individual differences.—Some people forget rapidly and others not so rapidly. The rate differs for different people and with the same person at different times and for different kinds of material.

The present experiment follows rather closely a study of incidental memory conducted by Letzer[25]. In her experiment two 16 mm. films were shown to groups of students. The first was a special action film prepared by Metfessel and Musgrave to measure memory. The second was one of Kellogg's Ape and the Child films. Series of questions were prepared based upon these films. One series of questions was given immediately after the showing of the films. The second set was given to different groups, one forty-eight hours, another one week, and another four weeks after the film had been shown. The films were seen only once and no person answered any group of questions more than once. Scores were computed in terms of the percentage of immediate memory. With one film the percentage retained for forty-eight hours was ninety-six, with the other ninety-one per cent was retained. After one week ninety-eight and eighty-one per cents, respectively, were retained for the two films. This is in marked contrast with Ebbinghaus and even with other studies in which sense material was used.

The study reported here differs from the preceding in that there was a definite intention to try to remember. In the present study the Seashore memory cards were used. These consist of a picture of a complex office scene with a man and a woman shown in the office. Each subject was given a card and was permitted to look at the picture for thirty seconds. Three sets of eleven questions each were based upon the picture. One set was given for immediate memory; another set was presented forty-eight hours later; and a third set, seven days later for one group and thirty days for another. The questions were rotated with different groups to equalize their difficulty. Recall was measured in terms of the per cent of immediate recall. One group of eighty-eight subjects recalled eighty-five per cent as much after forty-eight hours as immediately after seeing the picture, and another group of twenty-four recalled eighty per cent as much. The first group recalled eighty per cent after one week and the second seventy per cent after thirty days.

As a subsidiary study the subjects were asked to indicate the confidence in their answers. If they were 'willing to swear' to the correctness of their answers they were to double check an answer. If they were relatively certain of their answer they were to single check it. If they 'guessed' there was to be no check. These results were quantified by giving two points for a true double check, one for a single check, zero for no check, one was deducted for a wrong single check and two was deducted for

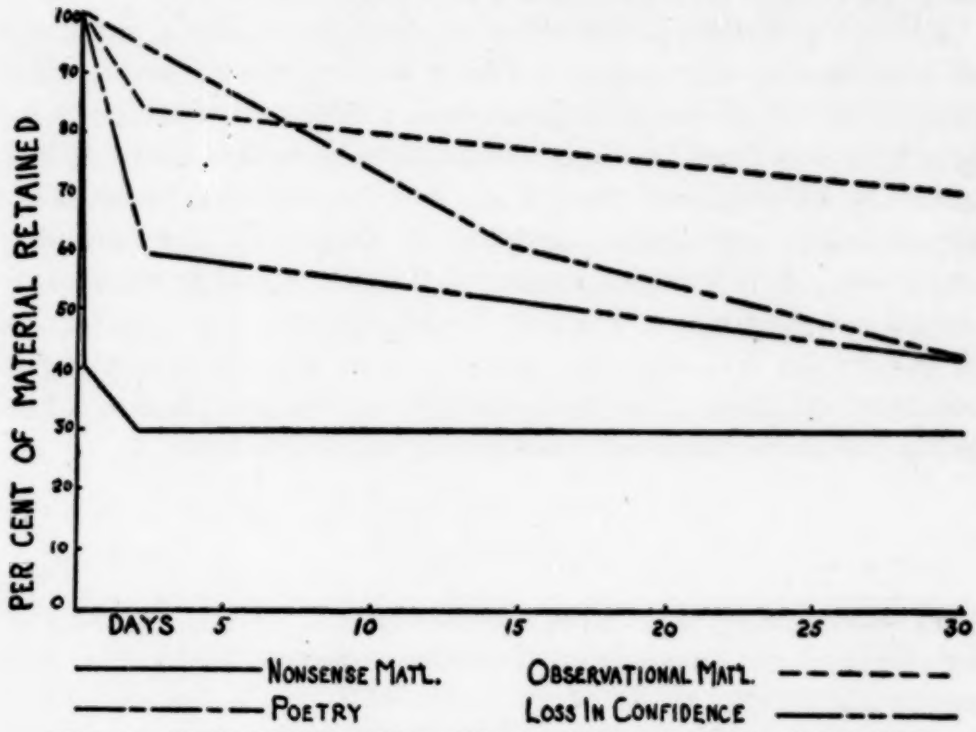

Fig. 1. Typical Rates of Forgetting for Different Kinds of Material.

a double check that was wrong. There was a forty per cent loss in confidence with eighty-eight cases after forty-eight hours, and sixty per cent, with twenty-four other cases. After one week there was sixty per cent loss with the first group and after one month seventy-five per cent with the other. This shows clearly that there is a much more rapid loss in confidence than there is in recall of facts. This loss of confidence, of course, has considerable significance in testimony in courts.

In summary how may we account for the great differences in rate of forgetting between Ebbinghaus and the present study? Certainly one cause of difference is the type of material. Non-

sense syllables have few associations and forgetting is rapid. This is especially true when long series are used. Ebbinghaus found more rapid loss than most others using nonsense material. This may be partly explained by the length of his series. Ebbinghaus says that he became fatigued and often developed headaches in his learning. This was not conducive to a high interest. In contrast our pictures were interesting and the experiment was short. Ebbinghaus is not clear in his explanation, but it is likely that retroactive inhibition also reduced his recall.

Enough different factors affecting recall have been pointed out to explain the differences between Ebbinghaus' results, other typical studies of recall, and our own. While our conditions for retention may have been somewhat more favorable than typical, certainly Ebbinghaus' results are not typical and presents an unjustifiably pessimistic picture of forgetting for ordinary materials. It is here recommended that textbooks in psychology should not continue to publish the Ebbinghaus curve as typical of forgetting, but only as typical of the rate of forgetting of nonsense syllables under the condition of his experiment. Forgetting of sense material is ordinarily much less rapid.

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THE ABILITY OF CHILDREN TO READ CONVENTIONALIZED DIAGRAMMATIC SYMBOLS

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Elementary-school reading materials ofttimes contain a number of diagrams. The flow of material through an industrial process, the exchange of material between an organism and its environment, the operation of a gasoline engine—these and many other relational concepts are communicated in diagrammatic form. In general, whenever it becomes necessary to communicate a constructional, organizational or operational relationship in a pictorial representation, the diagram is employed.

Most diagrams can be analyzed into three components: a) symbolic representations of the objects entering into the primary relationship (e.g., outlines of cylinders); b) verbal symbols, inserted on or near the central objects (e.g., 'Start Here'); and c) symbols other than verbal, but performing many of the same functions (e.g., arrows, to represent motion). The last mentioned are referred to here as 'conventionalized diagrammatic symbols.'

Reading a diagram would entail a) reading meaning into the various symbols present; b) integrating these various symbols; and c) integrating the diagram with supporting materials, verbal and otherwise. This statement should not be interpreted to mean that the psychological events described always occur in that order. The events do occur, but the order of occurrence probably depends upon the children and diagrams involved.

The writer could not find any studies by other authors dealing with the ability of children to read diagrams. In order to establish principles for the construction of diagrammatic materials, information of this sort is necessary. The present study is concerned with one aspect of this extensive problem.

PURPOSE

The ability of children to read diagrams can be measured in at least two ways: First, their reactions to the total diagrammatic configuration and supporting materials can be measured. Secondly, their reactions to specific parts of the diagram can be

measured. The merit of the latter approach is that a measure of reactions to specifics allows us better to interpret reactions made to the whole. The second approach was utilized in this study.

The writer wished to test two hypotheses:

a) The ability of elementary-school pupils to read conventionalized diagrammatic symbols increases from Grade IV through Grade VIII.

b) The ability to read a conventionalized diagrammatic symbol varies significantly with the subject-matter (total diagram) containing the symbol.

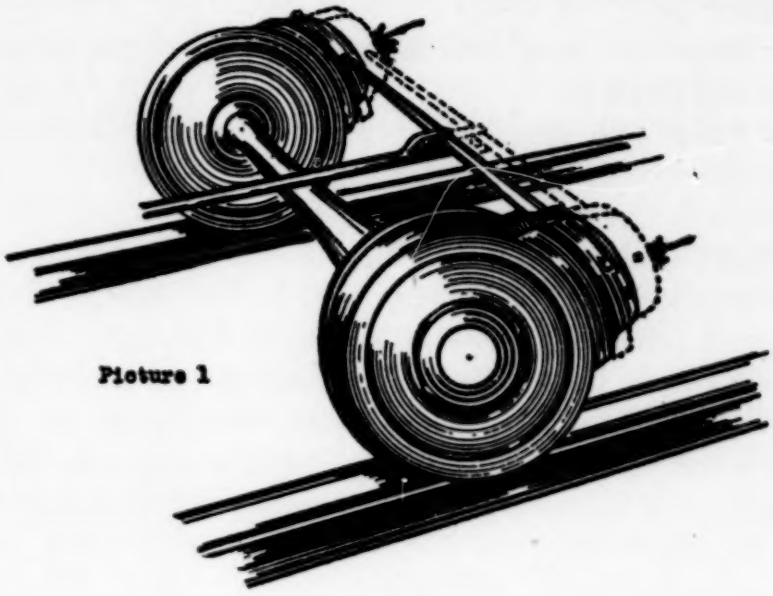
A number of children's encyclopaedias and textbooks were examined and the five most frequently recurring conventionalized diagrammatic symbols were isolated. They were: a) the 'dash-line,' indicating displacement or movement; b) the 'straight-line,' relating members of a family; c) the 'arrows,' designating motion; d) the 'circle,' framing an enlargement; and e) a 'wavy or serrated edge,' indicating a cutaway.

Diagrams containing these symbols were especially prepared. Each symbol was incorporated into two diagrams. For example, the dash-lines, indicating items in motion, were incorporated into both Pictures 1 and 6 (Fig. 1). Certain of the pictures prepared for the study might be considered realistic drawings rather than diagrams. It was difficult to control this latter factor, for the distinction between a realistic drawing and a diagram is not clearly established.

The illustrations were planographed and distributed along with mimeographed answer sheets to one hundred fifty-seven pupils, grade IV through VII in School A. An entire class was tested at once. The pupils' attention was directed to Picture 1, and the following directions were given in both oral and printed form: "The red arrows are pointing to dash-lines. Why are these dash-lines in the picture?" The pupils responded freely. Similar directions were given for Pictures 2–10, appropriate words being substituted wherever necessary.

The responses made by the pupils were next analyzed. It was found that many pupils, especially those in the lower grades, had failed to respond on some pictures. These omissions could have resulted from a) the pupils' failure to recognize the symbols, or b) their inability to communicate what they knew to be the correct response. An objective test, consisting of a question and five

choices, was consequently constructed. The multiple choices were selected from the responses made by the pupils in School A.



Picture 1

Picture 6

Fig. 1. Both Pictures 1 and 6 contain dash-line symbols. The arrows appeared in red and directed the pupils' attention to the dash-lines.

For example, the question and multiple choices for Picture 1 were:

"The red arrows are pointing to dash-lines. Why are these dash-lines in the picture?

a. To show where the next train can get on

b. The dash-lines show where the upper part of the wheel is
c. The dash-lines show a part which is holding the wheels together
d. The dash-lines show that the part in front of them moves back and forth
e. The artist put the dash-lines in to help him keep the other lines in the picture straight"

'd' obviously is the correct answer.

The multiple choice test was administered to three hundred seventy-six pupils, grades IV through VIII in Schools B, C and D. School B was a private institution, located in Chicago. Schools C and D were public institutions located in Indiana and Wisconsin, respectively. Again an entire class was tested at once. This time, however, the children responded merely by circling the letter in front of the choice that they considered correct.

RESULTS

The first hypothesis to be tested was: The ability of elementary-school pupils to reach conventionalized diagrammatic symbols increases from Grade IV through Grade VIII.

The percentage of pupils in each class correctly interpreting

TABLE I.—PERCENTAGES OF THE PUPILS IN EACH GRADE CORRECTLY RESPONDING TO THE DIAGRAMMATIC SYMBOLS. (TOTAL FOR ALL SCHOOLS)

Grade	IV	V	VI	VII	VIII
No. of children	68	66	89	71	70
Mn IQ	109	113	113	110	118
Mn CA	119	133	144	156	170
Picture 1 Dash-lines	24	53	53	58	53
Picture 6 Dash-lines	49	67	73	63	73
Picture 2 Straight-line	19	42	54	41	80
Picture 7 Straight-line	53	67	80	75	92
Picture 3 Arrows	68	85	84	85	96
Picture 8 Arrows	66	67	88	86	90
Picture 4 Serrated or Wavy edges	46	76	61	68	80
Picture 9 Serrated or Wavy edges	74	89	57	89	96
Picture 5 Circle	47	65	70	75	80
Picture 10 Circle	66	92	75	93	89

the symbols in each of the ten pictures was calculated. Table I shows the results for all schools combined.[1] Thus, the following percentages of pupils in each grade correctly interpreted the symbols (dash-lines) in Picture 1: Grade IV, 24 per cent; Grade V, 53 per cent; Grade VI, 53 per cent; Grade VII, 58 per cent; Grade VIII, 53 per cent. The pictures containing similar symbols are paired in Table 1: 1 and 6; 2 and 7; . . . 5 and 10.

From an inspection of Table I, it is apparent that the hypothesis stated above is strictly true in only one instance, Picture 5. In all other instances some intermediate class upset what might be considered a trend in support of the hypothesis.

More specifically, the results for all schools combined reveal:

a) In practically every instance, more children correctly interpreted each of the symbols than would be expected by chance alone.

b) The arrows and circles appeared easiest for the children to interpret.

c) Noticeable percentage differences appeared between the following adjoining classes: Grades IV and V on Pictures 1, 2 and 10; Grades VII and VIII on Picture 2; and Grades V and VI on Picture 10. In order to determine if these differences were statistically significant, the following technique was employed: First, for Grades IV and V on Picture 1, the larger percentage value was found; it was 53 per cent. The difference between the larger and smaller percentage values was calculated; it was 29 per cent. The number of cases in each group was found; there were sixty-eight cases in Grade IV and sixty-six cases in Grade V. A chart[2] was then employed which indicated the number of cases necessary in each group before an obtained difference was significant at the one per cent level of confidence. It was found that the obtained difference was significant at the one per cent level in this instance.

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[1] Results were calculated for each class in the separate schools. The trends were similar in all three schools. The children in School B did better in most instances. This is understandable, for they are exceptionally bright and consistently rank one or two grades above the norm on most standardized tests.

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The same technique was employed with the remainder of the groups. The differences were significant at the one per cent level of confidence in all four groups.

The second hypothesis to be tested was: The ability to read a conventionalized diagrammatic symbol varies significantly with the subject-matter (total diagram) containing the symbol.

Table I, as previously stated, groups the pictures containing the same symbols in pairs. In order to determine if the hypothesis stated above is true, the results shown in Table I are not sufficient. For example, 24 per cent of the sixty-eight children in Grade IV correctly interpreted the symbol in Picture 1; 49 per cent of the children in Grade IV correctly interpreted the symbol in Picture 6. Offhand, one might conclude that the hypothesis stated above was true in this instance, for twice as many children correctly interpreted the symbol when it was incorporated into Picture 6. However, the results in Table I are insufficient because they do not reveal what children were involved in each percentage result.

In order to test the second hypothesis, then, the following statistical technique was employed: First, for Grade IV, Pair 1–6, the number of children who correctly interpreted the symbol in Picture 1, but who misinterpreted the symbol in Picture 6 was calculated; there were nine such cases. Next, the number of children who misinterpreted the symbol in Picture 1, but who correctly interpreted the symbol in Picture 6 was calculated; there were twenty-five such cases. To determine if the differences between these correlated proportions was significant, a table prepared by Swineford[3] was employed. The difference in this instance was significant at the one per cent level of confidence.

The rest of the data was treated similarly, and the following results were obtained:

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[3] Swineford, Frances, Unpublished Table.
The Table was based on the following formula, developed by McNear:

$$\chi^2 = \frac{(D - A)^2}{D + A}$$

(See McNemar, Quinn, "Note on the Sampling Error of the Difference between Correlated Proportions or Percentages," *Psychometrika*, v. 12, No. 2, June, 1947, pp. 153–157.)

a) In Grades V through VIII more pupils correctly interpreted the dash-lines, straight-lines and circles when they were incorporated into Pictures 6, 7 and 10, respectively. With four exceptions, these differences were significant at the one per cent level of confidence. The exceptions were: Grade VI, Pair 5–10; Grade VII, Pair 1–6; Grade VIII, Pairs 1–6 and 5–10.

b) In a number of instances more children correctly interpreted the arrows and serrated or wavy edges when they were incorporated into Pictures 8 and 9, respectively. (See Table I.) The differences, however, were significant at the one per cent level in only two cases: Grades IV and VII, Pair 4–9.

c) In a number of instances, more children correctly interpreted the arrows and serrated or wavy edges when they were incorporated into Pictures 3 and 4, respectively. These differences, however, were not statistically significant in any instance.

One might conclude, then, that the second hypothesis can be accepted in some cases and rejected in others.

INTERPRETATION OF RESULTS

The first hypothesis to be tested was rejected in most instances. From an inspection of Table I, however, it is apparent that a trend in support of this hypothesis exists. The hypothesis was rejected merely because the percentages did not increase consistently. The irregular growth pattern may be explained in at least two ways: a) The interpretation of these symbols is not systematically stressed throughout the grades; b) The percentages were computed on the basis of one picture. It is possible that an expanded test would reveal progressive growth in this ability.

In most instances a significantly larger number of pupils correctly interpreted a symbol when it appeared in the higher numbered member of each pair. When the pairs were planned, the writer attempted to include more familiar subject-matter in the higher numbered member of each pair than in the lower numbered one. For example, dash-lines were incorporated into both Pictures 1 and 6 (Fig. 1). The subject-matter in Picture 6 would seem to be more closely related to the children's experiences than that in Picture 1. This attempt to distinguish the subject-matter probably accounts for the significantly larger

number of pupils recognizing the symbol in the higher numbered member of each pair in most instances. Stated in other terms, meaningful wholes probably furnish clues for interpreting specifics contained therein.

CONCLUSIONS

1) An illustrator preparing materials for children may use the following symbols with a reasonable amount of confidence: arrows, designating motion; circles, framing enlargements; and, possibly, wavy or serrated edges, indicating cutaways.

2) The children experienced difficulty in interpreting the following symbols: dash-lines, indicating displacement or movement, and straight-lines, relating members of families.

IMPLICATIONS

The fact that many of the pupils tested could not correctly interpret certain conventionalized symbols does not necessarily argue for the exclusion of these symbols. An illustrator may contend that a diagram should be explained to children, and that in the process they will learn to interpret the conventionalized symbols contained therein. On the other hand, pupils ofttimes do attempt to read diagrams without adult help. In those instances, the inclusion of certain symbols—dash-lines, for example—might limit the usefulness of the diagram.

The findings indicate that the nature of a diagram influences the ability of children to interpret the included symbols. On the other hand, the ability to read meaning into specifics paves the way for reading meaning into the whole. Children, consequently, should be helped to interpret these diagrammatic symbols through an organized plan. Added emphasis might be placed on the interpretation of these symbols in the classroom situation. The fact that diagrams consist of abstract symbols is often overlooked by sophisticated adults. Editors might interpret these symbols in captions. If this latter suggestion is impractical, a number of pages explaining these symbols might be inserted somewhere in the reading material.

READABILITY OF BOOK PRINT AND NEWSPRINT IN TERMS OF BLINK-RATE*

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Rate of involuntary blinking has been extensively used by Luckiesh[2] and by Luckiesh and Moss[4] as a criterion of readability and of ease of seeing. Tinker[5] and Bitterman[1] have questioned the validity of blink frequency as a measure of readability of print and as an index of ease of visual work. In reply to these questions, Luckiesh[3] has claimed that the test procedures used by Tinker and by Bitterman do not correspond to those employed by him and that the obtained results, therefore, are not comparable. The present experiment aims to duplicate the experimental conditions specified by Luckiesh in his work.

Specifications cited by Luckiesh are as follows: (a) The subjects should be accustomed to reading steadily and continuously. (b) The subjects should not be required to perform other tasks during the reading. But the readers are allowed to turn the pages of the reading material. (c) Text read should be interesting but low in emotional value. (d) Only one variable, such as typographical variation or level of illumination, should be involved. (e) The subjects are to read in a natural manner under normal conditions. (f) In general, a period of five minutes of reading is adequate, but in some cases it is advisable to repeat the series of measurements and use the combined score. (g) Luckiesh favors the direct method of observation for recording the number of blinks during the reading period. (h) According to the writer, another point may be added. There should be an adequate number of subjects and there should be statistical evaluation of the significance of the differences discovered. These conditions have been fulfilled in the present experiment.

The present investigation is concerned with the validity of blink frequency as a criterion of readability of newsprint in comparison with book print. A study of Paterson and Tinker[6] revealed that newsprint was read significantly slower than book print when each are printed in an optimal typographical arrange-

* The writer is grateful to the University of Minnesota Graduate School for a research grant to finance this study.

ment for the size of type involved. Luckiesh and Moss[4] report a study on blink rate for reading six-, eight-, ten-, and twelve-point type, with shorter lines for the smaller type sizes. The results are said to indicate that the six-point type is somewhat less readable than the larger types.

In the present experiment the material to be read was the following: (1) The book print was an interesting biography (Winkler's *Morgan the Magnificant*) set in twelve-point type with two point leading in a twenty-three pica line width on a good quality of Matt-white paper. This typographical arrangement, according to the findings of Paterson and Tinker[5], is optimal for twelve-point type and is as readable as nine-, ten-, and eleven-point type when these are set in optimal arrangements. This book print, therefore may be considered representative of highly readable book printing. (2) For the newsprint material, stories of general interest but unemotional in character were cut from a newspaper, the Mankato (Minnesota) *Free Press*, and mounted on cardboards. The text was set in seven-point type with one-point leading in an eleven and one-half pica line width on regular newsprint paper stock. According to Tinker and Paterson[9], this approximates the general trend in newspaper typography. Also, Tinker and Paterson[9] have shown that this printing arrangement is optimal for seven-point newsprint.

The experiment was carried out in a light laboratory with 10 foot-candles of well diffused illumination. Sixty university students served as readers for two experimental sessions each. The reading material was placed on an inclined stand at the normal reading distance from the subject, i.e., about fourteen inches.

The direct method of observing and counting eye blinks by a skilled experimenter was employed (Tinker[7]). On arrival at the laboratory the subject was adapted for five minutes to the illumination used. During this time he was told that this was an experiment on reading, and that we wanted him to read the material just as he was accustomed to read material of that kind, that is, to read it just as he would if he were reading at home. Then the subject was told to read the material at his usual rate and with his usual attitudes, to start at the indicated place and to continue until stopped.

At the first session, the book print was read first and the newsprint second. At the second session on another day, the order

was reversed. The subjects read for five minutes on each kind of material and the blinks were recorded. A rest of five minutes was allowed between the two kinds of reading. At the end of the session the subject was only asked how he liked the materials read. Every precaution was taken to maintain normal reading attitudes.

RESULTS AND DISCUSSION

The basic data for the frequency of blinking are listed in Table I. Mean scores are given for the two five-minute periods as well as for the ten-minute total. The standard deviations

TABLE I.—FREQUENCY OF BLINKING WHILE READING BOOK TYPE AND NEWSPRINT. $N = 60$ UNIVERSITY STUDENTS

	Book Type Scores			Newsprint Scores		
	First 5 Min.	Second 5 Min.	Total: 10 Min.	First 5 Min.	Second 5 Min.	Total: 10 Min.
Mean.....	34.28	35.08	69.37	31.77	29.50	61.27
SD.....	26.27	29.94	53.65	26.26	25.66	49.78

reveal marked variation among subjects in frequency of blinking. This confirms trends reported by Tinker[7]. Extremes revealed as few as five and as many as 172 blinks per five minutes. Nevertheless the means are much alike from one period to the next for the same kind of print. Reliability or consistency of performance is revealed by the following correlations:

Five-minute periods—book type,	$r = .82$
Five-minute periods—newsprint,	$r = .84$
Ten-minute periods—book type vs. newsprint,	$r = .95$

These reliabilities are relatively high and are satisfactory for the comparisons involved.

Other evidence indicates that, in comparison with newsprint, the book print has greater visibility (Luckiesh and Moss[4]) and is read faster (Paterson and Tinker[6]). The book print is set in an

optimal typographical arrangement ([5] p. 81) for rapid and easy reading. The readability of the book print, therefore, should be greater than that of the newsprint, for type sizes less than eight-point significantly reduce reading rate[5].

Examination of Table I shows that on the average, 69.37 blinks occurred for ten minutes of reading book print and only 61.27 blinks for the newsprint. Fewer blinks would, according to Luckiesh and Moss[4], indicate greater readability. The difference of 8.1 blinks is statistically significant for the critical ratio (D/SE_{diff}) is 3.7. In terms of blink frequency, then, the seven-point newsprint would seem to be more readable than twelve-point book type. But all other evidence points in the other direction, i.e., that book print is more readable. As noted above, visibility of newsprint is much less than that of book print and newsprint is read significantly slower than book print.

There are at least two possible ways to account for these results. In planning this experiment, it seemed that there was ample evidence that book print is more readable than newsprint. Hence, a comparison of the two should provide an adequate check on the validity of the blink technique as a measure of readability. First, therefore, one can raise the question of whether there was anything in the experimental set-up which prevented the severity of the visual task from being reflected in blinking, i.e., increased number of blinks for reading newsprint. The writer can think of nothing of this nature in the experimental situation. All the requirements laid down by Luckiesh were fulfilled. The alternative is that the blink technique is not a valid measure of the readability of print. This conclusion can only be tentative because of two factors: (1) The same number of blinks were not used for reading the two typographical arrangements. There were significantly fewer blinks for the newsprint. The 8.1 fewer blinks represent a difference of about 11.7 per cent. (2) The reliability of the blinking was relatively high. What factor caused significantly fewer blinks for reading newsprint than for book print is not clear. In any case, the results do not substantiate Luckiesh's claim that rate of involuntary blinking is a sensitive indicator of ease of seeing. Nevertheless, further research is needed to complete the evaluation of the blink technique as a measure of ease of seeing.

SUMMARY AND CONCLUSIONS

1) The purpose of this study is to check the rate of blinking as a criterion of readability by comparing blink rate while reading book print and newsprint.

2) Rate of involuntary blinking was measured for reading book print and newsprint under 10 foot-candles of well diffused light.

3) All requirements specified by Luckiesh for satisfactory use of the blink technique were fulfilled.

4) Significantly fewer blinks were employed for reading the newsprint. Since other cited evidence indicates that newsprint is less readable, the blink technique appears not to be valid as a measure of ease of seeing. Further checking of the validity of the blink technique is needed.

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A COMPARISON OF THE DALE, DOLCH AND RINSLAND WORD LISTS

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A comparison of the words included in the Dale list of seven hundred sixty-nine easy words,[1,3] the Dolch list of two hundred twenty common words in children's oral and reading vocabularies,[2] and a selection of the words in the Rinsland list most frequently used by children in their writing[4] shows a large amount of overlap and at the same time certain differences that are attributable to the nature of the lists and the way in which the words were selected.

The Dale list consists of the words common to the Thorndike first thousand most frequent English words in reading context and the first thousand most frequent words known by children on entering the first grade. The Dolch list of two hundred twenty words contains the commonest words in the textbook and speaking vocabulary of elementary-school children as determined from a number of different word counts. Dolch finds that these words make up more than fifty per cent of elementary-school textbook material. There are two hundred fifty-six words in the Rinsland list having a frequency of 3,000 or over for children's writing in grades I–VIII combined. This is the selection of words from the Rinsland list used for the present study. Table I shows these three lists combined. All words with the symbol 'o' are in the Dolch list, all words with the symbol + are in the Rinsland List. Words in capitals are in the Rinsland list but not in the Dale list; words in italics are in the Dolch list but not in the Dale list. All other words are in the Dale list. The total number of words in the three lists is three hundred twenty. Of these words, one hundred fifty-six are common to the three lists.

A substantial number of the words in Rinsland that are not in Dale are derivatives of root words that are already in the Dale list. It is interesting to note that the children 'laugh' in the Dale and Dolch lists but not the Rinsland, where they are more inclined to have 'fun.' Although the English experts frown on

'very,' this is a very popular word. Children in their writing send 'lots of love' presumably to Santa Claus, but this sentiment is less commonly expressed in the school texts.

USES OF HIGH FREQUENCY WORD LISTS

What are some of the practical uses that can be made of this combined list of words most frequently recurring in spoken, written and printed English? Anyone who is learning to read and write English is certain to meet these words oftener than any others. The full Dale list is employed in the Lorge formula for checking the readability of reading text.[4] To the Dale list might be added the capitalized and italicized words of the combined list given here.

These are the words that all children should certainly learn to spell and to recognize in print during the elementary-school years, and they would ordinarily take precedence in drill over other less common words. Any word that appears in all three lists rates priority in language instruction. If the child knows these basic words he has a frame-work for learning other less commonly used words.

It would be wrong to assume that in primary-grade teaching these words should all receive instructional emphasis ahead of any other words. For meaningful content reading the child will need to use and will easily learn to recognize common names of things in his experience and other words that are not listed here, for example 'squirrel,' 'pony,' 'Main Street,' 'grocery store,' 'Mr. Nash,' 'Valentine,' 'Thursday', and the like.

Furthermore, it would be wrong to give mechanical drill on this list of common words in isolation from content and to give each word an equal amount of drill in reading or spelling. Many of these words are best learned in association with other words for many of them do not represent anything concrete. They are relational words, generalized terms and represent attributes rather than the names of things. Since they recur so often in print and are used so frequently in writing they tend to be learned incidentally in language activities at school. 'Santa Claus' is an illustration of a word that tends to be learned without direct drill both because of its distinctive configuration and pleasant connotation.

TABLE 1.—COMBINED WORD LIST
o = Dolch List. + = Rinsland List

A

o +a
o +about
o +after
o +again
o +all
+along
+also
o +always
o +am
o +an
o +and
+another
o +any
o +are
o +around
o +as
o ask
+ASKED
o +at
o +away
o *ate*

B

+baby
+back
+ball
o +be
o +because
+bed
o +been
o +before
o +best
o +better
o +big
o +black
o blue
+book
o both
+boy
+BOYS
o +bring
+brother
o brown
o +but
o buy
o +by

C

o call
+CALLED
o +came
o +can
+car
o carry
+CAT
+children
+Christmas
o clean
+close
o +cold
o +come
+coming
o +could
+country
o cut

D

+DADDY
+day
+DAYS
+dear
o +did
+DIDN'T
o +do
+DOLL
o does
+dog
o done
o +don't
+door
o +down
o draw
o drink

E

+each
o +eat
o eight
o +every

F

o fall
o far
o fast
+father
+few
o +find
o +fine
o +first
o +five
o fly
o +for
o +found
o +four
+friend
o +from
o full

TABLE 1.—*Continued*

+FUN
o *funny*

G

+game
o +gave
o +get
+GETTING
+girl
+GIRLS
o +give
+glad
o +go
o +going
o *goes*
o +good
o +got
+GRADE
+great
o green
o grow

H

o +had
+happy
o +has
o +have
o +he
+heard
o +help
o +her
o +here
o +him
o +his
o hold
+home
+hope
o hot
+house
o +how
o hurt

I

o +I
+I'M
+if
o +in
o +into
o +is
o +it
o its

J

o jump
o +just

K

o +keep
o kind
+knew
o +know

L

+land
+large
+last
o laugh
o +let
+letter
o light
o +like
o +little
o +live
o +long
o +look
+LOOKED
+lot
+LOTS
+love

M

o +made
o +make
+man
o +many
o may
o +me
+men
+milk
+more
+morning
+most
+mother
o +much
o +must
o +my
o myself

N

+name
o +never
o +new
+next
+nice
+night
o +no
o +not
o +now

TABLE 1.—*Continued*

O

o +of
o +off
o +old
o +on
o +once
o +one
o +only
o open
o +or
+other
o +our
o +out
o +over
o own

P

+people
o pick
+place
o +play
+PLAYED
o +please
o +pretty
o pull
o +put

R

o +ran
o +read
o +red
o ride
o +right
+room
o round
o +run

S

o +said
+SANTA CLAUS
o +saw
o +say
+school
o see
o seven
o shall
o +she
+should
o show
o sing
+sister
o sit
o six
o sleep
o small
+snow
o +so
o +some
+something
o +soon
o start
+STARTED
o stop
+summer
+sure

T

o +take
+teacher
o +tell
o ten
+than
o thank
o +that
o +the
o +their
o +them
o +then
o +there
o +these
o +they
+thing
+THINGS
o +think
o +this
o those
+thought
o +three
+through
+time
o +to
o +today
o together
+told
o +too
+took
+town
+tree
o try
o +two

U

o under
+until
o +up
o upon
o +us
o use

V

o +very

TABLE 1.—*Continued*

W	o +went	o +work
	o +were	o +would
o walk	o +what	o +write
o +want	o +when	
+WANTED	o +where	Y
o warm	o +which	
o +was	+while	+year
o wash	o +white	+YEARS
+water	o +who	o yellow
+way	o why	o yes
o +we	o +will	o +you
+week	o +wish	o +your
o +well	o +with	

In preparing spelling lists and reading materials for intermediate and upper grade elementary-school pupils it would be advisable to keep an eye on this list to make sure that all pupils get practice with these frequently recurring words at the same time they are learning the less common words employed in their reading and writing vocabulary. This list should be a helpful guide in preparing simplified reading materials and spelling lists for slow learners.

There is an increasing tendency in school practice to combine the reading and the writing vocabulary for easier and more permanent word mastery. This combined word list lends itself well to unified language teaching in the lower grades.

One other use of this list might be mentioned, and that is for checking children's 'linguability,' or their use of English in conversation. One factor in rating maturation in oral language usage, just as in rating readability, is the commonness of the vocabulary employed. Rating a child's 'linguability' would afford an index of his readiness for reading and spelling instruction and aid in predicting the progress he might be expected to make in learning these skills.

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A STATISTICAL INDEX OF PARTICIPATION IN DISCUSSION

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One criterion of an effective discussion is the evenness of participation by the members of the group. Other things being equal, a discussion in which all members participate frequently is considered good. On the other hand, if one or two members of the group monopolize the discussion so that the others get little opportunity to speak, the discussion is considered poor.

The index below is proposed as a measure of the evenness of discussion:

$$\text{I.P. (Index of Participation)} = 100\left[1 - \frac{2\sigma^2}{(N-2)M^2}\right]^2 \qquad (1)$$

In this formula, N is the number of members of the discussion group. M and σ are the mean and standard deviation of the number of contributions to the discussion by the individual members of the group.

The index takes on a maximum value of 100 when all members of a group make the same number of contributions. In that case, $\sigma = 0$, and the whole term involving σ vanishes.

The index takes on a minimum value of 0 when two members of the group monopolize the discussion. It may be shown that σ^2 takes on a maximum value of $M^2\left(\frac{N-2}{2}\right)$ in such cases and that the function $\frac{2\sigma^2}{(N-2)M^2}$ therefore takes on a maximum value of 1. Proof:

1) The total number of contributions in any discussion is NM.

2) If two members monopolize the discussion, each makes $\frac{NM}{2}$ contributions.

* The author is indebted to Dr. James E. Greene, Dr. Fred Couey and Mr. Neal B. Andregg, associates on the Educational Advisory Staff of Air University, for discussion and criticism of this technique.

3) The square of this number is $\frac{N^2M^2}{4}$.

4) The raw score formula for the variance is: $\sigma^2 = \frac{\Sigma X^2}{N} - M^2$.

5) Since X^2 is $\frac{N^2M^2}{4}$ for each of the two monopolizers, and is 0 for all other members of the group, ΣX^2 for the group is $\frac{N^2M^2}{2}$.

6) Substituting in the formula,

$$\sigma^2 = \frac{N^2M^2}{2N} - M^2 = M^2\left(\frac{N}{2} - 1\right) = M^2\left(\frac{N-2}{2}\right).$$

The two examples below show intermediate cases.

Group 1			Group 2		
Individual	Frequency (X)	X^2	Individual	Frequency (X)	X^2
A	23	529	S	49	2401
B	17	289	T	2	4
C	12	144	U	11	121
D	5	25	V	3	9
E	10	100	W	5	25
F	16	256	X	15	225
G	9	81	Y	10	100
H	12	144	Z	9	81
Sum	104	1568	Sum	104	2966

To simplify the computation of an index, formula (1) may be written as follows:

$$\text{I.P.} = 100\left(1 - \frac{2[N\Sigma X^2 - (\Sigma X)^2]}{(N-2)(\Sigma X)^2}\right)^2 \qquad (2)$$

If we apply the index to Group 1, a fairly balanced discussion, we find

$$\text{I.P.} = 100\left(1 - \frac{2[8(1568) - (104)^2]}{6(104)^2}\right)^2$$

$$= 100\left(1 - \frac{2(12544 - 10816)}{6(10816)}\right)^2 = 100\left(1 - \frac{3456}{64896}\right)^2$$

$$= 100(1 - .053)^2 = 100(.947)^2 = 90.$$

If we apply the index to Group 2, a discussion largely dominated by one person, S, we find

$$\text{I.P.} = 100\left(1 - \frac{2[8(2966) - (104)^2]}{6(104)^2}\right)$$

$$= 100\left(1 - \frac{2(23728 - 10816)}{6(10816)}\right)^2 = 100\left(1 - \frac{25824}{64896}\right)^2$$

$$= 100(1 - .398)^2 = 100(.602)^2 = 36.$$

The rationale of the development of the index was as follows: A measure of the dispersion of the frequencies of participation will become small if all participate rather equally, but will become large if a few dominate discussion and others participate rarely. The standard deviation is the best index of dispersion to use because it gives great weight to extreme deviations. Except when all participate equally ($\sigma = 0$), the value of σ tends to increase with the total number of contributions made. Since the number of contributions is closely related to the length of the discussion, it is important to make a correction. The most appropriate correction is to divide by the average number of contributions. The next step is to work the ratio $\frac{\sigma}{M}$ into a formula that takes on the value 100 when $\sigma = 0$, and 0, if possible, when σ is a maximum. Any function of the form $100\left(1 - k\left(\frac{\sigma}{M}\right)^2\right)^n$ meets the first requirement, and use of σ^2 saves the necessity of taking square root. Since $\frac{\sigma^2}{M^2}$ takes on a maximum value of $\frac{N-2}{2}$, regardless of the number of participants, it is sufficient simply to give k the value $\frac{2}{N-2}$, the reciprocal of the maximum value, to cause the second term in the parenthesis to take on a maximum value of 1 under all

conditions. The total function then takes on a minimum value of 0. The value 2 was assigned to n because in the eyes of the author and his associates squaring the function yields a scale better suited to linear interpretation.

The Index of Participation has been developed in conjunction with studies of seminar discussions in the several schools of Air University. In these institutions for the education of Air Force officers in service, considerable use is being made of seminar discussions. They are considered not merely as means of securing solutions to problems, but as training for participation in staff conferences.

Data accumulated from flow charts of such discussions have been subjected to computation of indexes of participation. First applications indicate not only that the measure is a valid index, but also that it is a useful descriptive device. In several instances, deterioration of discussion in successive phases was clearly measured by decline of the index. In one case, the index declined from 85 to 63 to 33 in three successive phases. In one school, where three instructors' conferences were observed, the indexes ranked the instructors in the same order as previous general impressions of their supervisor. Elsewhere, observers noted a similar correspondence between estimates of the general excellence of discussions and indexes of participation.

Most discussions conducted by moderately experienced leaders yield indexes above 60. Although thus far the index has been applied to only twenty-four discussion periods, a pattern of interpretative values appears to be emerging, namely:

Above 90—Excellent, balanced discussion
80 to 89—Above average, well balanced discussion
70 to 79—Average, satisfactory discussion
60 to 69—Below average, poorly balanced discussion
Below 60—Very poor, unbalanced discussion

One refinement in the use of the Index of Participation is suggested tentatively. The flow charts used by one recorder provided for recording length as well as frequency of contributions. The recorder classified contributions as less than thirty seconds, thirty to sixty seconds, and over sixty seconds, and arbitrarily assigned weights of 1, 3 and 5, respectively, to these contributions in making his frequency counts. This made the frequency counts rough measures of time consumed by participants.

Indexes based on such data from ten sessions were inconclusive, but tended to be slightly higher on the average than the corresponding indexes based on the unweighted frequency counts.

The propriety of combining frequencies from several discussions by the same group is dependent on the kind of information sought. Indexes for separate discussion periods will describe the evenness of participation in each period. An index based on combined data from several periods will describe long-term tendencies. Each of several discussion periods might have low indexes, while the index for the series might be fairly large if different participants played leading rôles in different conferences. If the indexes for the several discussion periods are large, however, the index for the series will necessarily be large.

When research at Air University in evaluating seminar discussions by a variety of procedures, including the Index of Participation, accumulates to a sufficient extent or shows significant trends, suitable reports of findings will be made in professional journals.

DO CHILDREN THINK CRITICALLY ABOUT CLASSROOM PROCEDURES?

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"Some people wouldn't want to come to school if there were no activities," says Saundra.

" . . . Fun. We're having too much lately!" This is John's opinion.

"When you work on activities, you find out a lot of things you wouldn't find out otherwise—makes things more real," suggests Joan.

And so the children continued. A spontaneous discussion of 'activities' in the classroom is in progress.

Everyone has at some time expressed approval or disapproval of a classroom experience in which he was a participant. Such a remark is usually directed toward the teacher as the responsible agent of the school and generally carries implications for objectives, curriculum, method, or control. However, it is an indication of progress when the individual or group concerned begins to think objectively in terms of the problems involved.

The discussion which comprises the major part of this report was thought by the supervising teacher to contribute in a measure to four related educational problems. The problems are:

1) How much group activity is advisable in a given situation?

2) Are individual pupils conscious of the relation between method and achievement?

3) Do pupils use the same bases for judgments in these matters as do adults?

4) What is the relation of activity to work standards?

This discussion followed the giving of a puppet show by thirty sixth-grade children. There had been a number of extensive group activities related to science, social studies, group social activities, art, and language. Arithmetic and spelling had been more nearly confined to the academic boundaries of the subjects. The first half hour of each day was given over to the group consideration of any problem brought up by any individual. This practice helped to establish the idea that an individual was free to express himself without interference.

The supervising teacher was in charge at the beginning of the discussion. When he recognized the trend of the first three statements, he requested three student-teachers to keep as nearly an exact record as possible of what was said. They also participated in a part of the discussion. After the compilation of the statements, everyone approved and verified his remarks as they are shown here. Forms of expression have been left intact.

THE DISCUSSION

(1) Mike: "We come to school to learn and not to play."

(2) John: "We are having too many activity periods, too much fun, and no business. We should spend more time learning things. We learned nothing from the puppet show."

(3) Bill: "We are having too much activity, but I feel we learned something from the puppet show."

(4) Joan S: "Activities are not based on subject-matter but on the way we control ourselves and work with other people—teamwork."

(5) Leroy: "The reson for having activities is to give everyone something to do."

(6) Bob: "I think we should have a contest. Have people who don't like activities in one group and those who do in another. After two weeks have a test to 'know' who learned the most. Don't let all the 'smart' ones be in one group."

(7) Dick: "We are having too many activity periods. I suggest the last hour or half hour on Friday."

(8) Herman: "Activities are o.k. Each afternoon we learned about foreign countries and how they work and live."

(9) Carol: "I think we should have activities like Joan said. It gives responsibilities to people and helps them to finish their responsibilities."

(10) Saundra: "I agree with Bob."

(11) Jim: "I agree with Bob. I would go into the group which favors cutting down on activities, but not all of them."

(12) Jean: "I agree with Bill. We should have some activities, but the puppet show taught us a lot."

(13) Joan B: "I agree with Herman. We learn about other people so we will know how to treat them."

(14) John: "If we have a contest, Bob says not to put all the

'good guys' on one thing—then what if several good persons think some activity is best? I don't see why they couldn't be on it. Then it would be tough on those who didn't learn anything. Some would take activities because they are easiest, though."

(15) Joan S: "When you work on activities you find out a lot of things you wouldn't find out otherwise—makes things more real."

(16) Mr. Harris: "How many agree with Joan?" (Twenty-five)

(17) John: "I agree it does make it real, but we have too much."

(18) Bill: "I think activities do teach something—like Clarence learned to make ships; I learned about weapons. Saundra made pictures and learned about home-life. I think we should have activities two or three times per week—first hour of the day."

(19) Saundra: "We work and have activities together—a sort of mixture. Arithmetic is an activity."

(20) Suzanne: "I wouldn't consider arithmetic an activity."

(21) Bob: "Arithmetic does not mean anything unless you use it on something such as making drawings of buildings. You could read a social studies book and learn nothing. I feel that the puppet play was helpful. I learned to take care of myself. John wants to keep out fun."

(22) Jim: "You learn more when you have fun. Maybe some people think the other way. You don't enjoy a thing when you know you have to do it."

(23) Dorothy: "I think activities are all right. You might get up grouchy and activities will wake you up and get you in a good mood. I feel fine the rest of the day."

(24) Saundra: "Some people wouldn't want to come to school if there were no activities."

(25) Rosalee: "The school I came from had no activities. I believe we should have half and half."

(26) Dick: "I think we should have activities twice a week—first period Monday and last period Friday."

(27) Mr. Harris: "Do you consider the half-hour discussion and planning periods each morning an activity period?"

(28) Dick: "Sorta."

(29) Mike: "Sorta."

(30) Juanita: "Activities sometimes do lots of good; you can enjoy yourself and make lots of friends."

(31) Barbara: "We learn to work with each other, learn to like them and make more friends."

(32) Mr. Harris: "Do you agree that activities make you feel more as a group than as an individual?"

(33) John: "Mr. Harris, they got my idea mixed up. I didn't say I didn't want any fun periods and cut out all the fun! We're having too much lately! Bill said he learned those things, but, did he work to get them? About social studies, you would, but in puppet shows you don't. I think we should have a morning fun period."

(34) Dick: "I think that every time we have an activity we ought to have one or two people in charge of the whole group."

(35) Jim: "Leave it as it was."

(36) Joan B: "Everyone has an opinion of their own. You feel better when you have an activity."

(37) Joan S: "I want to make a correction—you can't have activities as the only thing. We have to have bases for the activities planned—must connect up with something."

(38) Mr. Harris: "In other words you feel that an activity is not just something to do."

(39) Bob: "They have to have a beginning."

(40) Carol: "I think that people who haven't had activities do not know how they work. The chairman is to help the rest of the committee and not to boss."

(41) Bill: "The one-half hour period at the beginning of each morning should be conducted by a couple of students—secretary or president to take up collections, dues, etc."

(42) John: "Clarence didn't go to a book, he just used his hands. Do you have to work to have an activity? When you draw a map, you just look at it and don't learn anything."

(43) Bill: "Drawing maps is hard work."

(44) Mr. Harris: "John, am I correct when I understand you to say that the thing you are worried about is not the activity itself, but a poor kind of activity?"

(45) John: "I'm not worried about anything. But I'm talking about the kind where you don't learn anything."

(46) Mr. Harris: "Let me ask you this question: Is this period an activity?"

(47) John: "No, it's a discussion."

(48) Mr. Harris: "How many of you feel it's an activity?" (About twelve) How would you describe it, Freddy?"

(49) Freddy: "Discussion."

(50) Herman: "Discussion."

(51) Bob: "Activity."

(52) Mr. Harris: "What have you learned during this period?"

(53) Carol: "I learned there are good activities and bad activities."

(54) Joan S: "I got more out of this than arithmetic, spelling, or anything."

(55) Joan B: "It was good because everyone got to say what he wanted to say."

(56) Miss McQueen: "John has a point. Some activities have no point or value. Seeing pictures may call for no thinking on the part of the children. Jim and Bob drew the pictures of buildings, but they did not read about them. Some activities are valuable. I think there should be a certain period for activities and that they should be carefully checked and supervised by teachers."

(57) Mrs. Pierce: "I believe in activities when they are meaningful. I agree with Dick that there should be time limits and special days."

(58) Mr. Ramsey: "First of all, I am handicapped in knowing how many activities you have had. Your comments as a whole are very worth while. I agree and disagree with John. It has to be directed in the right way. There must be results and not mere play. I am opposed to activities being on a certain day of the week. It would tend to be too mechanical. I would like to ask one question. Answer frankly. What did you consider the last half hour Friday when I taught?"

(59) Jerry: "Do you mean the one about Beethoven?"

(60) Mr. Ramsey: "Yes."

(61) Bob: "Activity."

(62) Jean: "Activity."

(63) Jim A: "Work."

(64) Saundra: "Activity and work."

(65) Joan B: "You told us something I hadn't known before. Discussion period."

(66) Joan S: "Work and discussion period."

(67) Carol: "Work and discussion period."

(68) Juanita: "Work and discussion period."

(69) John: "I don't know what it was. In an activity period you do something."

(70) Bill: "I think it was work. You told us to think of a poem and what it did to us."

ANALYSIS OF PUPILS' COMMENTS

An analysis of this discussion indicates that twenty-two of the seventy remarks are concerned with identifying an activity. Adults are probably more certain on this point, but might have difficulty in identifying particular situations as was the case here. One individual (69) indicates that "In an activity period, you do something." Two children approached the problem of the relation of activities to subject-matter. One boy (21) said: "Arithmetic does not mean anything unless you use it on something such as making drawings of buildings. You could read a social studies book and learn nothing . . . " Obviously, the boy was referring to a particular kind of reading.

The problem of the organization of activities was mentioned nine times. One girl (37) said: "We have to have bases for the activities planned—must connect up with something." Bill (41) would have the period to which he referred take on more of the characteristics of social organization.

Considerable attention was given to the proportion of the total time which should be devoted to activities. John (2) stated one position by saying: "We are having too many activity periods, too much fun and no business." The majority seemed to agree with Jim who said: "I would go into the group which favors cutting down on activities, but not all of them."

The girl making comment (23) seemed to get an unusual effect from activities. She was probably referring, however, to the informal planning and conversation period scheduled for the first half-hour of the day. Comment (30) shows the value of activities in furthering adjustment for one child. Response (14) stated one position on activities by the comment: "They are easiest." The next comment (15) points out, however, that activities "make things more real."

The five problems listed in the introduction of this report were treated as follows:

1) How much group activity is advisable in a given situation?

The group seemed to feel that there had been too many activities in their situation. Only a few were definitely prejudiced against activities. Most seemed to prefer the better organized subject-matter related type in which the purposes and objectives were clearly evident.

2) Are individual pupils conscious of the relations between method and achievement?

Apparently they are, for the initial remarks in the discussion treated this topic. Of course, the finer relationships are not clear, but there is a concern for 'getting it done', and method is recognized as a vehicle in this process.

3) Do pupils use the same bases for judgment as adults?

Factors such as achievement, satisfaction, and content entered into the judgments of these children as they analyzed their own particular situation. The fact remains, however, that while these factors were present, the immaturity of the students' thinking is evident.

4) What is the relation of activity to work standards?

This problem was related by the children to the second problem. The consideration of activity as anything from fun to work indicates a less refined concept here. Judgment on this question seemed to vary from individual to individual. Further, each individual seemed to regard activity as related to work standards in a rather consistent manner. This probably reflects the manner in which the individual making the comment had learned to participate in activities.

CONCLUSIONS

The value of this discussion, of course, could not be measured objectively, but there was evidence of many desirable outcomes.

First, the discussion stimulated thinking on the part of the children and the teachers. The discussion was started by the children themselves; therefore, there was interest in the subject being discussed and a desire to express one's own opinion upon the question at hand.

Second, there was ample opportunity for each child to give oral expression upon a subject which was of vital importance to him as shown by the number of children who took part in the discussion. The need to express oneself in a clear and concise

way was felt by each child because he was participating in a discussion, the results of which would affect him directly. This was evidenced by the fact that the children often repeated what they had said to make sure that everyone clearly understood their remarks.

Third, the opportunity for 'psychological expression' was great. Every child had a chance to voice his own thoughts about the activity program which had been carried on, knowing that he would not meet disapproval because of what he said.

Fourth, the discussion re-defined the direction which group procedure was to take. That is, it helped the teachers and the children to see that there was a problem and that a new course of action should be considered.

From the discussion, it can be seen that children do attempt to think critically about classroom procedures.

BOOK REVIEWS

LEONARD CARMICHAEL AND WALTER F. DEARBORN. *Reading and Visual Fatigue.* Boston: Houghton Mifflin Co., 1947, pp. 483.

The plan of this treatise is to summarize and discuss relevant literature, to describe a new method for the quantitative study of visual work, and report new experiments which seem to contribute to the understanding of visual fatigue. Examination of the literature revealed diverse definitions of fatigue and many different approaches to experimentation on the subject. Therefore, the investigator who plans to study visual fatigue must decide in advance exactly what he is to measure. In the present experiments, a comprehensive quantitative study of changes resulting from prolonged visual work was planned. Fatigue is used as a descriptive term and takes account of changes in subjective state as well as change in output of work, i.e., work decrement.

In considering the visual task of reading in relation to the study of visual fatigue, attention is given to the variety of eye movements involved, the fixation pause, sequence of movements, reaction time of the eye, and speed of eye movement. The data cited on speed of eye movement and on eye movements during the reading of different kinds of material, however, are less adequate than more recently published data on the subjects. Survey of the relevant literature on reading and fatigue suggest that certain changes may occur in the reading pattern under conditions of continuous exercise. Data on the rôle of involuntary blinking as an indication of fatigue in reading are equivocal. Much of the data cited question the validity of blinking as a measure of severity of visual work.

Since it is necessary, in an investigation of fatigue in reading, to specify carefully the printed format, the literature on the readability of various typographical arrangements is reviewed. On page 102 it is stated that the tachistoscopic exposure time employed in these studies is typically less than required for 'a reflex movement' of the eyes. It would be more meaningful to state that these exposure times were less than the (voluntary) reaction time of the eye. In general the survey of typographical

variations in relation to readability is very well done. In some instances, however, the authors are uncritical of results from poorly designed experiments, i.e., Gilliland's report. Again, one wonders why so much space is devoted to results from second-grade readers when the authors are concerned with the reading of adults. Also the authors state (p. 110) that the confusion (i.e., conflicting results) in data from experiments on size of type may be due to the very short time allowed for the reading. They suggest continuous reading by a number of subjects for adequate results in this kind of study. This interpretation is probably wrong. Gilliland's experiment is not relevant here since he enlarged and reduced photographically a standard paragraph printed in twelve-point type. This does not duplicate printing practice. Furthermore, there is evidence showing that exactly the same trend in results is found when the reading interval is lengthened as was discovered for the shorter (one and three-quarters minutes) time.

In experiments on visual fatigue from continuous reading it is important to provide proper lighting. After an excellent survey of the literature, the authors chose sixteen foot-candles as adequate for the reading to be done in their experiment. The conclusions that led to this choice are in line with sound experimental findings.

The section on the recording of eye movements contains the best survey and evaluation of the subject that the reviewer has seen. The authors correctly concluded that electrical recording of eye movements is best suited for use during continuous reading like in their experiment. A few questions may be raised concerning the material presented. There are more recent and more adequate data on the fixation movements of the eye than the study cited. It might be added also that an important disadvantage of direct methods of observing eye movements is inaccuracy. An appreciable number of movements are missed.

The latter half of the book is devoted to a description of the apparatus used in the authors' studies and to reporting the results obtained. An electrical recording device was employed, as noted above. Records were obtained of turning of pages, horizontal eye movements (reading movements), blinking indicated by vertical eye movements, brain potentials, and heart beat.

Twenty college and twenty high-school students were subjects. Each subject read for two six-hour periods, easy material at one sitting, and difficult economic material at the other. Some read book print, others read microfilm. Records from four subgroups yielded data on both high-school and college students for the above measures. The experiment was well conceived, neatly designed, and well controlled. The data are adequately analyzed.

Space will allow citation of only a few of the results and conclusions. Computations were based upon samples of five minutes of reading at beginning of first half hour and at end of each of the twelve half hours. There were no significant changes in the various measured aspects of the eyes' behavior (blinking, fixation number, fixations per line, fixation sigma score, regression number, and regressions per line) in reading during an experimental six-hour period. This was true for both college and for high-school students while reading either book print or microfilm. No single factor in the experimental situation produced special differences in ability to read for six hours. Thus microfilm produced no more evidence of 'fatigue' than book print. Subjective reports indicated that, for many of the subjects, the reading became increasingly unpleasant as the time of the experiment passed. But the total visual mechanisms was able to function approximately as effectively at the end of six hours of reading as at the onset of the activity. It was not found, therefore, that reading for this long period of time was done at any 'cost' to the organism. It is suggested that the introduction of tests at the end of each twenty-five pages controlled and maintained motivation more constant than in an earlier four-hour experiment where a work decrement did appear. Finally, it is concluded that "In the use of a mechanism as well protected against the deleterious effects of the prolonged work of normal reading as is the visual mechanism, the first index of fatigue seems to come in the alterations of the *general* attitudes and *general* feelings of the subject, not in a breakdown of the sensory-neuromuscular mechanism which actually performs the task." Apparently there is no basis for the belief that requiring long period of reading on the part of high-school and college students may be injurious to the visual mechanisms of such students.

This important book represents without question a landmark

in the experimental study of reading and visual fatigue. The analysis of relevant literature and the conclusions derived from this analysis are sound and are done in an excellent manner. Careful reading of the treatise revealed only a few minor points to criticise. The experimental design and the thorough analysis of data collected set a high standard for work in this field.

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G. W. ALLPORT AND L. POSTMAN. *The Psychology of Rumor.* New York: Henry Holt and Company, 1947, pp. 247.

The Psychology of Rumor makes an important contribution to social psychology. It could without distortion of fact be styled 'a treatise on the dynamics of human behavior.' The 'rumor principle' is applicable to many forms of human behavior, and its elaboration in this book helps us to understand this behavior. The motive power is human need—hope, fear, hate, anxiety, bewilderment, etc. The stores 'relieve, justify, and explain.' Rumor "rationalizes while it relieves." For example, the malicious rumors circulated in certain quarters about the Negro, the Jew, or other minority groups serve, by putting these individuals in the worst possible light, to justify existing attitudes, and, as they justify, to relieve the rumor-bearers of a sense of guilt occasioned by the attitudes.

Parallels are drawn between rumor, on the one hand, and testimony, as in Stern's work, and remembering and reporting as in Bartlett's, Henderson's, and Wulf's work, on the other. Rumor spreading involves perceiving, remembering, and reporting. Analysis reveals the presence in rumor of selection, leveling, sharpening, assimilation, and other forms of distortion as set forth in the standard works just mentioned.

A good share of this volume is taken up with a description and analysis of the authors' own experiments on 'rumor.' These experiments consisted chiefly in subject *A*'s listening to a description of a picture which he himself could not see and subsequently relating this description to *B* who did not hear the original and who does not see the picture, and in *B*'s relating it so *C*, who in turn relates it to *D*, and so on—with the result that what the last subject heard had been retold several times, all of which went

forward in an audience situation. The reader may or may not admit that these experiments in 'cold rumor' satisfy the conditions set forth in the 'basic law of rumor'—$R \sim i \times a$, in which i stands for importance (emotional intensity) of the theme to the speaker and listener and a, ambiguity. However, they do represent good experiments on perceiving, remembering, and reporting and as such demonstrate that in these aspects of rumor the same dynamic factors are present as are present in observing, remembering, and reporting in non-rumor situations. They scarcely get at the distinguishing features of rumor; at least do not do so very well.

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CORRECTION

In the paper, "The Power of the t Test and the Estimation of Required Sample Size" on pages 329–342 of volume 38, October 1947, there appeared the following typographical errors due to the necessity of going to press without author's proof corrections:

P. 331, line 6. The formula should read:

$$s^2 = \frac{1}{n_1 + n_2 - 2}\left[\Sigma_1(x - \bar{x}_1)^2 + \Sigma_2(x - \bar{x}_2)^2\right]$$

P. 331, lines 14 and 17. The direction of the inequalities should be reversed.

P. 333, footnote. The last expression should be

$$\sqrt{(n_1 + n_2)/(n_1 n_2)}.$$

P. 334, line 4. Read 1.753 for 1.750.

P. 334, note under Figure 2. Read lower case s for cap S before the radical.

P. 339, line 6. The expression for D should read:

$$D = \frac{d}{\frac{s\sqrt{2}}{\sqrt{n}}} = \frac{d\sqrt{n}}{s\sqrt{2}} = d'\sqrt{n}$$